

## **Marine Harpacticoid Copepods of Genus *Eudactylopus* (Harpacticoida, Thalestridae) in Korea**

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### **ABSTRACT**

Two marine harpacticoid copepods are newly recorded from Korea: *Eudactylopus spectabilis* (Brian, 1923) and *E. andrewi* Sewell, 1940. Six species are currently recognized in the genus *Eudactylopus*, multitude of which were often disputed among authors on their taxonomic status, so we treat here the taxonomic features of the two species above on the basis of specimens from South Sea and East Sea of Korea. *E. spectabilis* occurred first outside the Mediterranean Sea, and is fully redescribed with illustrations. Important male characters like the shape of leg 2 endopod and leg 5 with its setal arrangement are particularly emphasized as the diagnostic characters.

Key words: Taxonomy, marine, Copepoda, Harpacticoida, Thalestridae, *Eudactylopus*, Korea.

### **INTRODUCTION**

Six species are currently recognized in genus *Eudactylopus*, *E. robustus* (Claus, 1863), *E. spectabilis* (Brian, 1923), *E. andrewi* Sewell, 1940, *E. atlanticus* Vervoort, 1964, *E. australis* Nicholls, 1941 and *E. lucayosi* Geddes, 1969.

*E. latipes* (T. Scott, 1893), the specific name of which was later rejected by Vervoort (1964) due to its homonymy with *Paradactylopodella latipes* (Boeck, 1864), was subdivided into two forms, *E. latipes* f. *typica* and *E. latipes* f. *andrewi* by Sewell (1940). These two forms were revised as two subspecies, *E. andrewi atlanticus* and *E. andrewi andrewi* by Vervoort (1964), and subsequently

regarded as two distinct species, *E. atlanticus* Vervoort and *E. andrewi* Sewell respectively by Ito (1974).

Besides the species above mentioned, a few species were nominated. *E. opima* (Brian, 1927) was regarded as a synonym of *E. robustus* by Lang (1936) (cited from Lang, 1965). *E. fasciatus* Sewell, 1940, and *E. striatus* Sewell, 1940 which were described relying upon only one sex or an immature stage and upon the color pattern of the specimens, were considered each as a subspecies or another junior synonym of *E. robustus* by Noodt (1955), and cited without special comments in Vervoort (1964) and Lang (1965), to remain not settled as *species incertae* in Bodin (1988). *E. krusadensis* Krishnaswamy, 1950 was ignored as a misidentification for a species of Diosaccidae (Lang, 1965).

As a result of examining our collection from South Korea, two species belonging to genus *Eudactylopus* were determined as *E. spectabilis* and *E. andrewi* from 18 localities. In this paper, we deal with the taxonomic features of these two species, especially the redescription with illustrations of *E. spectabilis* which has previously been restricted to the Mediterranean Sea and newly recorded from the Pacific, on the basis of Korean specimens.

Collections were made with a dipnet of no. 10 mesh aperture or a light trap. Specimens were dissected, figured and measured in lactophenol on the Cobb's aluminum hole slide. Figures were made with the aid of drawing tube. All samples examined are deposited in the Department of Biology, Taegu University.

## SYSTEMATIC ACCOUNTS

Genus *Eudactylopus* A. Scott, 1909

### 1. *Eudactylopus spectabilis* (Brian, 1923) (Figs. 1-2)

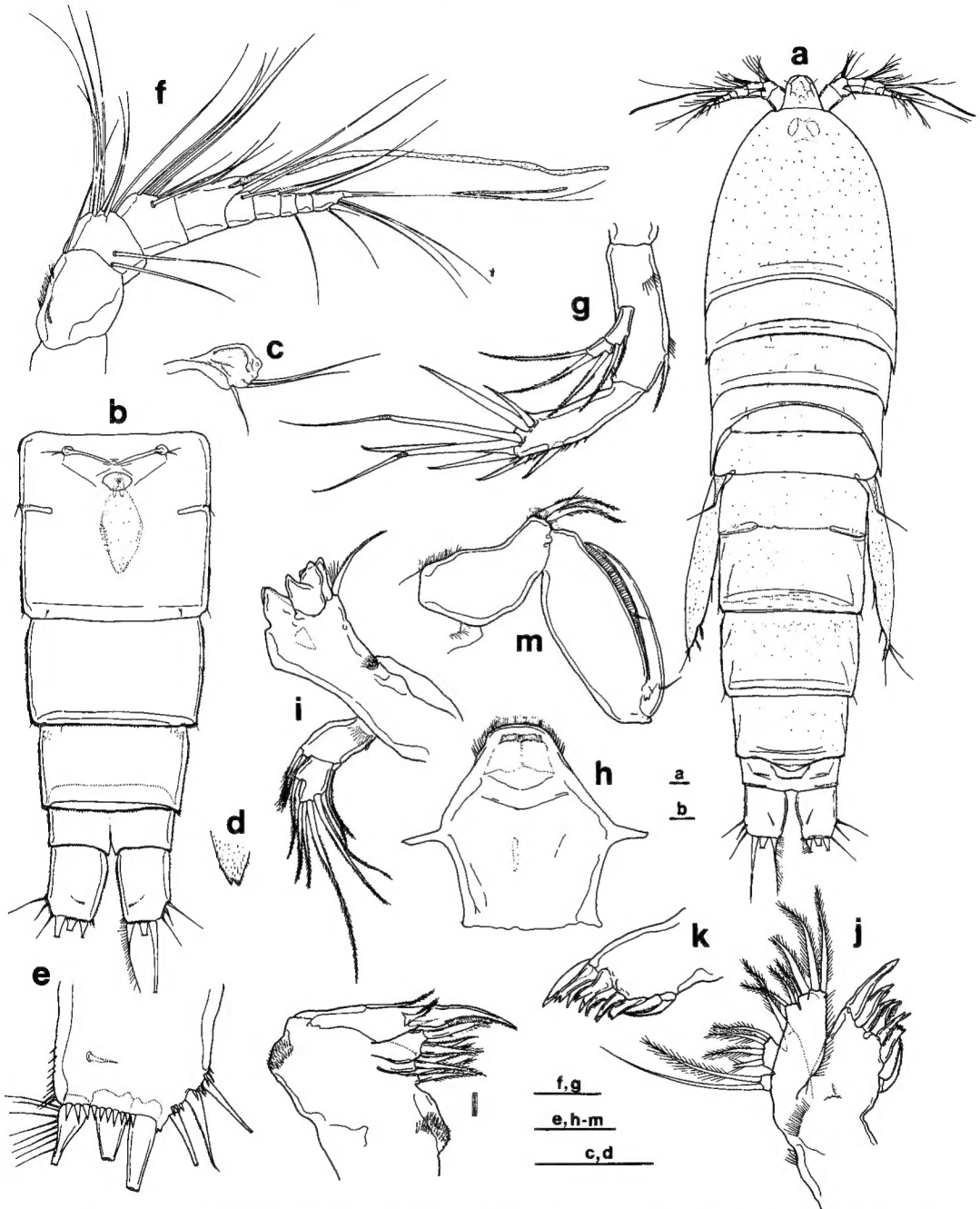
*Parathalestris clausi* var. *spectabilis* Brian, 1923, p. 129, fig. 4.

*Parathalestris spectabilis*: Brian, 1928, p. 4 (cited from Vervoort, 1964).

*Eudactylopus latipes* f. *typica* (non Sewell, 1940): Noodt, 1955, p. 58, figs. 6-12.

*Eudactylopus spectabilis*: Monard, 1928, p. 356, fig. 21-2 (cited from Lang, 1948); Lang, 1948, p. 561, fig. 228; Vervoort, 1964, p. 163; Pesta, 1959, p. 125, fig. 58; Marcus and Por, 1960, p. 151, pl. 3, figs. 14-17; Apostolov and Marinov, 1988, p. 132.

**Material examined.** 2♀♀ (ovi.), 2♂♂, Yangyang-gun, Namae-2-ri, 4 Oct. 1991; 2♀♀ (1 ovi.), Yangyang-gun, Namae-2-ri, 8 May 1993; 21♀♀ (5 ovi.), 2♂♂, Yangyang-gun, Namae-2-ri, 8 July 1994; 1♀ (ovi.), Ullŭng I., Taeha-ri, 4 Mar. 1995; 3♀♀, Ullŭng I., Kadubong, 9 July 1993; 7♀♀ (4 ovi.), 14♂♂, Ullŭng I., Chŏnbo, 2 Mar. 1995; 4♀♀, Ullŭng I., Chŏdong, 18 July 1994; 35♀♀ (11 ovi.), 13♂♂, Ullŭng I., Chŏdong, 9 Apr. 1995; 5♀♀, 1♂, Ullŭng I., Todong, 12 Apr. 1995; 1♀ (young), Yŏngil-gun, Chosa-ri, 27 June 1990; 4♀♀ (2 ovi.), 6♂♂, Yŏngil-gun, Wolp'o-ri, 27 June 1990; 4♀♀, Yangsan-gun, Taebyŏn, 25 Nov. 1992; 12♀♀ (9 ovi.), 1♂, Yangsan-gun, Taebyŏn, 4 Feb. 1993; 2♀♀, Tolsan I., Imp'o, 13 Oct. 1989; 14♀♀ (5 ovi.), 4♂♂, Cheju I., Chungmun, 14 Jan. 1995; Cheju I., Sŏkwip'o, 20 Apr. 1995. All drawings of female are based on the specimen from Cheju I., Chungmun, 24 Jan. 1995 (Cr321101-697-1), and of male from Cheju I., Chungmun, 24 Jan. 1995 (Cr321101-799-1), except Fig. 2f from Ullŭng I., Chŏdong, 9 Apr. 1995 (Cr321101-697-1).



**Fig. 1.** *Eudactylopus spectabilis* (Brian), female: a, habitus, dorsal; b, abdomen, ventral; c, leg 6 on genital double somite; d, bifid-tip plate of anal somite; e, furcal ramus, ventral; f, antennule; g, antenna; h, labrum; i, mandible; j, maxillula; k, praecoxa of maxillula; l, maxilla; m, maxilliped. (all scales: 50  $\mu$ m).

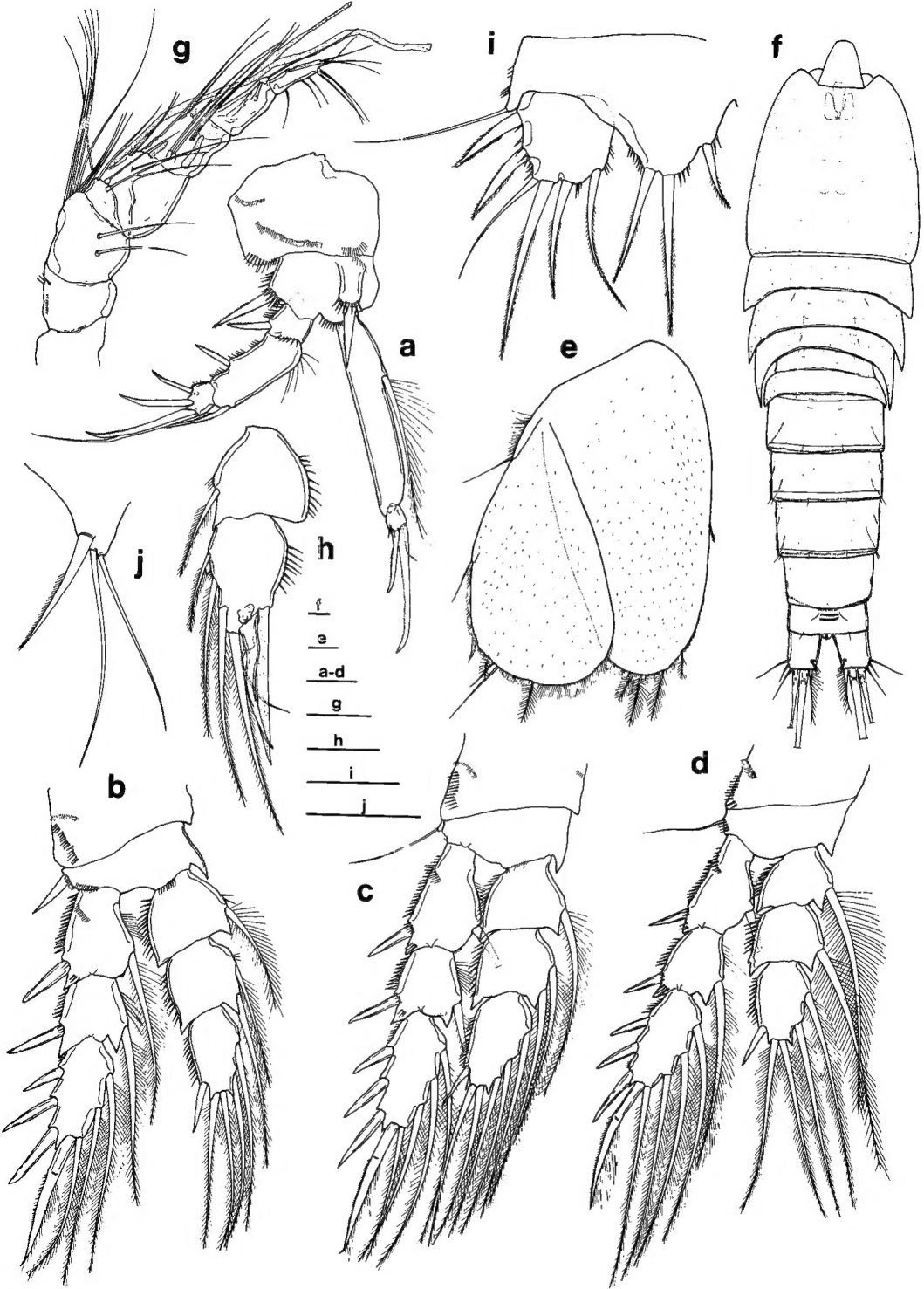
**Female.** Body (Fig. 1a) huge, mean length 1.35 mm of 8 individuals, rostrum and furcal setae excluded. Rostrum prominent and triangular, defined at basis, about 1.56 times as long as wide. Cephalothorax tapering apically with many delicate hairs on surface. Each thoracic somites (Fig. 1a)

ornamented with a row of a number of fine spinules. Genital double-somite partly fused, with numerous delicate hairs on whole dorsal surface. Third and fourth somites bearing a row of spinules on posterior edges of ventral side. Inner distal corner of anal somite with a pair of bifid-tip plate (Fig. 1d) covered with minute hairs. Furcal ramus (Fig. 1e) truncate, about 1.35 times as long as wide; outer furcal setae normal; inner distal seta bulbisetose at its base. Antennule (Fig. 1f) 9-segmented; proximal segment largest; aestetasc arising each from fourth and apical segment. Antenna (Fig. 1g) with allobasis; exopod composed of 2 segments, proximal one about 2 times longer than distal one, each bearing 2 and 3 setae respectively. Labrum (Fig. 1h) fairly sclerotized, with numerous hairs on its posterior margin. Mandible (Fig. 1i) with praecoxa long and thick; cutting edge with about 4 blunt teeth and a spinulose seta; coxa-basis with two spinulose setae on inner distal corner; endopod with 6 setae in total; exopod represented by a small protuberance with 2 setae on outer distal corner of coxa-basis. Maxillula (Fig. 1j) with arthrite of praecoxa bearing 7 strong teeth and a spinulose seta on posterior edge. Maxilla (Fig. 1l) with syncoxa bearing two clusters of spinules on lateral surface near base and on outer distal corner, and armed with 3 endites, proximal endite smallest with 2 setae; second endite rounded at tip and armed with 2 setae; distal endite with 3 setae; basis armed with a strong claw bearing 3 spinulose setae near base. Maxilliped (Fig. 1m) with basis bearing 3 spinulose setae on inner distal corner; first endopodal segment with a spinular row on inner margin and with 2 hairs; distal segment forming a strong claw. Leg 1 (Fig. 2a), endopod longer than exopod; exopod consist of 3 segments, second one longer than sum of the others; exopod not reaching end of first endopodal segment; endopod 2-segmented, with a seta on proximal one-third of inner margin; second one with 2 long claws and a seta on distal end, inner claw about twice as long as outer one. Both rami of legs 2-4 (Figs. 2b, c, d) consisted of 3 segments. The ornamentation of legs 2-4 as follows (Roman numerals indicating spines, and arabic numerals representing setae):

Leg 2	basis 0-I	exopod	1-I, 1-I, 2-2-III
		endopod	1-0, 2-0, 2-2-I
Leg 3	basis 0-1	exopod	1-I, 1-I, 3-2-III
		endopod	1-0, 2-0, 3-2-I
Leg 4	basis 0-1	exopod	1-I, 1-I, 3-2-III
		endopod	1-0, 1-0, 2-2-I

Leg 5 (Fig. 2e) well-developed, foliaceous, distal end of baseoendopod reaching end of exopod; baseoendopod larger than exopod, with 4 setae located on distal corner and a seta on proximal three-fifth of inner lateral margin, 2.14 times longer than wide; exopod about 1.93 times longer than broad, with 6 short setae on outer margin. Both rami covered with long hairs on distal rim. Leg 6 (Fig. 1c) on anterior part of genital double-somite ventrally, represented by a protuberance bearing 3 bare setae.

**Male.** Body (Fig. 2f) 1.52 mm (mean length of 10 individuals), gradually tapering posteriorly. Antennule 7-segmented, not exactly counted because of complicate articulation. Aesthetasc each arising from fourth and fifth segment. Endopod of leg 2 (Fig. 2h) remarkably modified, composed of 2 segments; first segment with 1 inner seta; second one 1.92 times longer than broad with 4 normal plumose setae along inner margin, 1 bare seta on distal protuberance, 1 sickle-shaped process at distal end, and 1 sharpened process on outer margin. Leg 3 and leg 4 same as in female. Leg 5 (Fig.



**Fig. 2.** *Eudactylopus spectabilis* (Brian), female: a-e, legs 1-5. male: f, habitus, dorsal; g, antennule; h, endopod of leg 2; i, leg 5; j, leg 6. (all scales: 50  $\mu$ m).

**Table 1.** Measurement of *Eudactylopus spectabilis* (Brian, 1923)

Parameter	Females (N = 8)	Males (N = 9)
	Range (Mean $\pm$ SD)	Range (Mean $\pm$ SD)
Length to width ratio of rostrum	1.28-1.83 (1.56 $\pm$ 0.17)	
Length to width ratio of furcal ramus	1.11-2.00 (1.35 $\pm$ 0.26)	1.17-1.48 (1.35 $\pm$ 0.08)
Length of 1st segment to 2nd segment of antennule	1.45-1.90 (1.71 $\pm$ 0.15)	
Location of inner seta on leg 1 endopod	0.31-0.54 (0.38 $\pm$ 0.07)	0.22-0.42 (0.35 $\pm$ 0.05)
Length to width ratio of distal segment of male leg 2 endopod		1.53-2.19 (1.92 $\pm$ 0.21)
Spine length to 2nd endopod segment of male leg 2		1.50-2.39 (1.87 $\pm$ 0.23)
Outer seta to innermost seta of male leg 5 baseoendopod		1.50-2.30 (1.82 $\pm$ 0.28)

2i) with baseoendopods widened and fused with each other, each with 3 thick setae, outer one 1.82 times longer than innermost one; distal end reaching base of innermost seta of exopod; exopod nearly as long as wide with 6 setae, arrangement as shown in Fig. 2i. Leg 6 (Fig. 2j) represented by 1 inner spinulose seta and 2 slender setae.

**Measurements and variation.** Measurement from eight adult females and nine adult males from total four localities are shown in Table 1. All females and males examined had biarticulated antennal exopod except for a male with uncertain subdivision from Cheju I., Chungmun, 24 Jan. 1995: In leg 5, two of eight females and one male had baseoendopod reaching end of exopod. In all mounted specimens, the following characteristics were consistent: inner proximal seta of female baseoendopod located at proximal 3/5 of inner margin; first endopodal segment of male leg 2 shorter than second one; second endopodal segment of male leg 2 bearing 4 plumose setae along inner margin; sickle-shaped process of second endopodal segment not reaching end of sharpened process; outer seta of leg 5 exopod in male over 1.5 times longer than innermost one.

**Remarks.** *E. spectabilis* was originally described as *Parathalestris clausi* var. *spectabilis* from Rovigno in Italy by Brian (1923), and thereafter the records have been restricted to the Mediterranean and its adjacent seas: Banyuls-sur-Mer (Monard, 1928), Aegean Sea (Brian, 1928), Marmara Sea (Noodt, 1955 as *E. latipes* f. *typica*), Napoli (Pesta, 1959), Yalta of Crimea Peninsula (Marcus and Por, 1960) and Bulgaria (Apostolov and Marinov, 1988).

Some discrepancies between our specimens and some records from the Mediterranean are noticeable: (1) from Brian's original description, the number of inner plumose seta on second endopodal segment in male leg 2 is 4, while 3 in Brian (1923), and (2) from Pesta (1959) and Marcus and Por (1960), judging from their insufficient figures of female only, their furcal rami are nearly as broad as long while obviously longer (1.35 times) in ours. These discrepancies may be attributable partly to the different process in preparation and the observation under improper illumination, or partly to the geographical variation between the Mediterranean and the western Pacific. Noodt (1955) reported *E. latipes* f. *typica* from Marmara Sea, but later it was considered as *E. spectabilis*

by Lang (1965) and referred by Ito (1974) again. Our specimens are in good agreements with Noodt (1955)'s description and figures, especially in furcal ramus, 2-segmented exopod of antenna, and distal endopodal segment of male leg 2 with 4 inner plumose setae.

Although some discrepancies above-mentioned and the distributional gap lying between Korean and the Mediterranean population, their distinction as two separate taxa seems to be not so crucial on morphological grounds. In our opinion, dissenting with Lang (1948)'s, the diagnostic characters differentiating the present species from its related species, especially *E. robustus*, must be the shape of male leg 2 endopod and leg 5 as Noodt (1955) suggested. As for the above characters, our male specimens exactly coincide with Brian's and Noodt's, so we identify our specimens as *E. spectabilis* provisionally. Later study on the copepodid stages for the populations from the Pacific and the Mediterranean with those of other congeners as Ito (1974) dealt in *E. andrewi*, and further records on this species from other regions will settle this problem.

The present species is commonly occurred from East Sea, South Sea and Cheju I. in Korea, and is one of the most dominant species collected by light trap around harbours.

**Distribution.** Rovigno (Italy); Banyuls-sur-mer (France), Aegean Sea, Marmara Sea (Turkey), Napoli (Italy), Yalta, Bulgaria, Korea (East Sea, South Sea, Cheju I.).

## 2. *Eudactylopus andrewi* Sewell, 1940 (Fig. 3)

*Dactylophus latipes*: T. and A. Scott, 1903, pp. 238, 268.

*Eudactylopus latipes*: A. Scott, 1909, p. 219, pl. 63, figs. 8-14 (cited from Vervoort, 1964); Lang, 1948 (in part), p. 561, fig. 227-2; Raibaut, 1962, p. 96, fig. 7.

*Eudactylopus latipes* f. *andrewi* Sewell, 1940, p. 201, figs. 31-33.

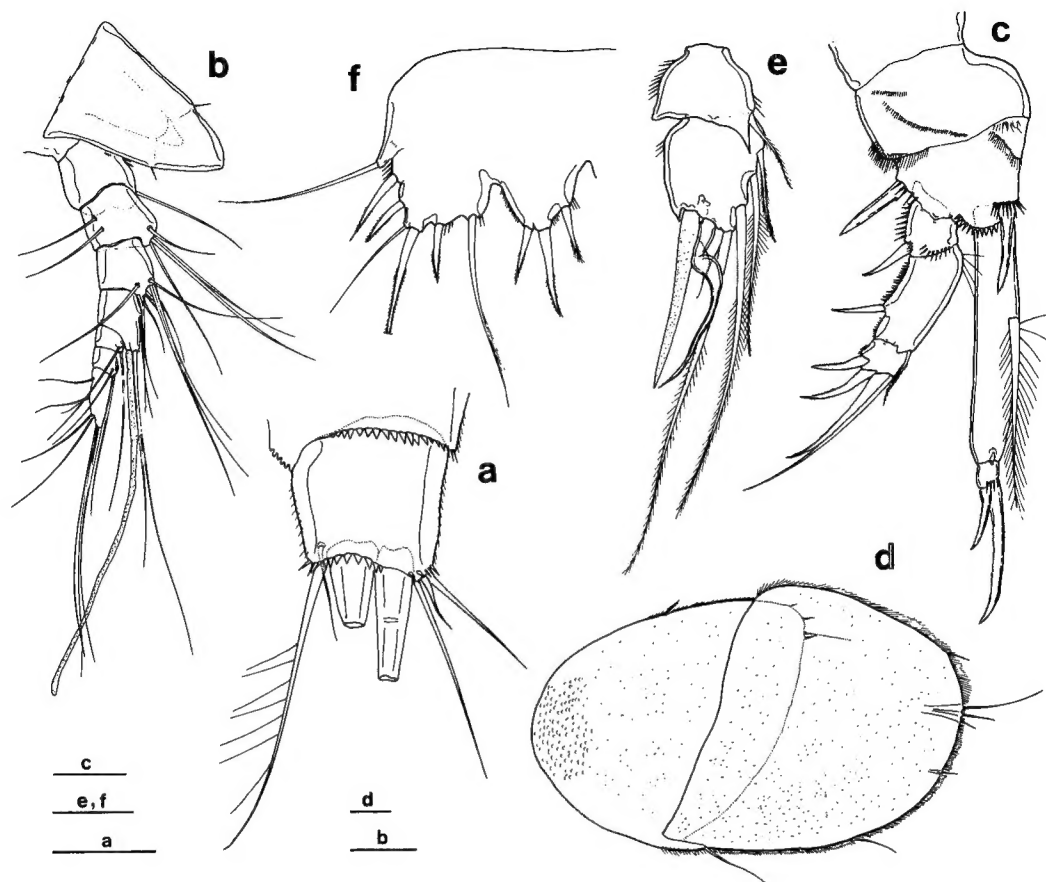
*Eudactylopus andrewi andrewi*: Vervoort, 1964, p. 154, figs. 56-59.

*Eudactylopus andrewi*: Ito, 1974, p. 580, figs. 16-27.

**Material examined.** 4 ♂♂, Ullung I., Ch'önbu, 2 Mar. 1995; 2 ♀♀, Namhae-gun, Sangju-ri, 3 July 1991; 7 ♀♀, 2 ♂♂, Cheju I., Sögwip'o, 29 Oct. 1993; 13 ♀♀ (8 ovi.), Cheju I., Chungmun, 24 Jan. 1994. All drawings of female are from the specimen (Cr321102-697-1) of Cheju I., Chungmun, 24 Jan. 1994, and of male from Cr321102-799-1 of Ullung I., Ch'önbu, 2 Mar. 1995.

**Measurements and variation.** Measurements from six adult females and four adult males examined are shown in Table 2. In all the mounted specimens, following characteristics were consistent: antennal exopod biarticulated with two setae on proximal segment, and three setae on distal one in both sex; inner proximal seta of leg 5 baseoendopod located near middle of inner margin; first endopodal segment of male leg 2 always shorter than second one; sharpened process slightly not reaching end of sickle-shaped process; first outer spine of leg 5 baseoendopod in male longer than second one.

**Remarks.** *Eudactylopus andrewi* has rather complicated taxonomic background as summarized by Bodin (1988). Sewell (1940) subdivided *E. latipes* into two forms, *E. latipes* f. *typica* and *E. latipes* f. *andrewi* for designating the Atlantic and the Indo-Pacific populations respectively. And then Vervoort (1964) reported the "Indo-Pacific" forms as *E. andrewi andrewi* from the Caroline Is., the Atlantic, and nominated another Sewell's form (*E. latipes* f. *typica*) as a distinct subspecies *E. andrewi atlanticus*, the record of which were still confined to the Atlantic at that time as the specific name referred to. However, Lang (1965) recorded *E. atlanticus* from Monterey Bay, California



**Fig. 3.** *Eudactylopus andrewi* Sewell, female: a, furcal ramus, ventral; b, rostrum and antennule; c, leg 1; d, leg 5. male: e, endopod of leg 2; f, leg 5. (all scales: 50  $\mu$ m).

reserving the species name of *E. latipes* f. *typica*, and suggested that *E. latipes* f. *andrewi* Sewell should be regarded as a separate subspecies or species. Subsequently Ito (1974) raised them to specific level, *E. atlanticus* and *E. andrewi* based on the number of antennular segment, the situation of proximal seta on leg 5 baseoendopod, the shape of leg 5 exopod and the position of the inner seta on first endopodal segment of leg 1.

Reconfirming Ito's diagnostic characters above are consistent with Korean specimens, we agree to Ito's opinion. Our specimens fitted well with Ito's elaborate redescription for *E. andrewi* except for a minor discrepancy that the first segment of antennule is 1.7 times the length of second one in females, while nearly 2 times in Ito's figure. By the way, Ito (1974) didn't emphasize particularly the male characters like the shape of leg 2 endopod and leg 5 as the diagnostic characters, supposedly for there were no elucidation on male of *E. atlanticus* comparable to *E. andrewi*. However, these characters cannot be overemphasized as the diagnostic ones, because the appendages are modified to geniculate organs showing reproductive isolation, and the cases are common in many genera particularly of Thalestridae and Diosaccidae. Summing up the dependable references (Raibaut, 1962;



**Table 2.** Measurement of *Eudactylopus andrewi* Sewell, 1940

Parameter	Females (N = 6)	Males (N = 4)
	Range (Mean $\pm$ SD)	Range (Mean $\pm$ SD)
Length to width ratio of rostrum	1.52-1.76 (1.57 $\pm$ 0.10)	
Length to width ratio of furcal ramus	0.90-1.16 (0.99 $\pm$ 0.09)	0.91-1.01 (0.96 $\pm$ 0.04)
1st segment of antennule to 2nd segment	1.32-1.73 (1.57 $\pm$ 0.13)	
location of inner seta on leg 1 endopod	0.42-0.50 (0.45 $\pm$ 0.03)	0.38-0.52 (0.45 $\pm$ 0.05)
Length to width ratio of distal endopodal segment, male leg 2		1.53-1.94 (1.69 $\pm$ 0.15)
Apical spine to 2nd endopodal segment of male leg 2		2.89-3.27 (3.13 $\pm$ 0.15)
Outer seta to innermost seta of male leg 5 baseoendopod		0.79-1.14 (1.04 $\pm$ 0.14)

Vervoort, 1964; Ito, 1974), the male characters above in *E. andrewi* show remarkable consistency: (1) distal segment of leg 2 endopod nearly rectangular; (2) at the segment, the shape and relative length of outer two modified spines (especially the sickle-shaped spine); (3) in the confluent leg 5, exopod slightly not reaching the end of baseoendopod with their unique setal arrangement. These characteristics of *E. andrewi* are conspicuously different from those of its congeners like *E. robustus*, *E. spectabilis* and *E. lucayosi*. Compared with the specimens from western Pacific (Ito's and ours), some minor discrepancies can be noticeable with the specimens from Indian Ocean and the Atlantic: the sickle-shaped spine on leg 2 endopod in Sewell (1940)'s figure is a little longer than its outer spine with bifid tip, and the outermost seta on leg 5 baseoendopod in Vervoort's male is somewhat shorter than its neighboring ones.

The present species, *E. andrewi* often co-occurred with *E. spectabilis* in light traps around harbours in Korea, but the former is easily discernable from the latter by the number of antennular segment, and the shape of female leg 5 and male leg 5.

**Distribution.** Sri Lanka, Malay Archipelago, Maldive Archipelago, Caroline Is., Japan (Kyushu, Hokkaido), Korea (East Sea, South Sea, Cheju I.).

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